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A Multiphase Reactor

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Field of the Invention

This invention relates to a multiphase reactor, particularly, to a gas-liquid-solid or gas-liquid, gas-solid, liquid-solid multiphase reactor.

Background of the invention

Multiphase reactors are widely used in various industry sectors such as metallurgy, chemical engineering, petrochemical engineering, and environmental protection. Owing to the particularity of different application fields, the reactor components that speed up reactions among gas-liquid-solid three-phase or gas-liquid, gas-solid, liquid-solid two-phase should have their own characteristics, according to practical requirements. For instance, the Chinese patent No. ZL98113470.x, entitled "*A Multiphase Jet Osmotic Dissolution reactor*", discloses a reactor including a spherical perforated focused injector, a draft tube, an expanding vessel and an osmotic cavity. Its characteristics are that the small conical orifices on the surface of the spherical body of the spherical perforated focused injector are connected to transferring conduits of the multiphase-fluid, respectively; the expanding vessel consists of a cone-shaped cavity and an expanding cone, with clearance between them; there are cylindrical orifices with convex helical bore line on the top end of the small conical orifices of the spherical body, and there is a short inward convex helical bore line on the inner wall of the draft tube terminal. Aiming at improving the osmotic effect of at least two-phase fluids, this prior art invention is made with its own characteristics of a build-in member. The inventor of the present application had presented a set of new technical solutions in the process of solving pollution problems of sulfur dioxide-containing flue gas which was discharged during metallurgical processes, achieving the object of "*waste treats waste, waste to wealth*." For the said new technical solutions, two Chinese patent applications concerning processes and main apparatuses have been filed with the Chinese Patent Office respectively, with the patent application number 00119453.4 and 02203582.6. In addition, a Chinese application for patent for invention had also been filed, with the patent application number 01126707.0. The patent for utility model No. ZL02203582.6, with the title of "*A Multiphase Reactor*" had been granted. The patent ZL02203582.6 is mainly concerned about a cone-shaped build-in member, composed of a cone-shaped ring and a cone body, which is mounted inside the reactor. Owing to the said build-in member, the velocity and direction of the fluids inside the reactor are forced to change continuously, so as to strengthen the contact among gas, liquid and solid phases and to improve the reaction process. Meanwhile, the build-in member can retard the

deposition of solid materials in the reactor. This kind of build-in member is simple in structure, and can prevent corrosion and abrasion readily. The conical surfaces of the cone body and conical ring housing of this conical build-in member are rotation surfaces formed by rotating straight lines, as a generatrix, round a rotation axis. However, these rotation surfaces can hardly fit for complicated practical situations. If the generatrix is changed from straight lines to a curved line as required, then the curved line is rotated round the rotation axis to form rotation surfaces, the rotator and annular rotator, which are formed by the above-mentioned rotation surfaces, replace the previous *cone* body and *conical ring;* the rotary build-in member, comprised of the rotator and the annular rotator, replace the previous conical build-in member. The rotary build-in member can effectively improve the flow pattern of the fluids and improve the contact among gas, liquid and solid phases of the reactants, and speed up the mass transfer Therefore, the multiphase reactor could fit with more situations, and could be employed in even more three-phase or two-phase reactions.

Summary of the invention

The object of this invention is to provide a multiphase reactor with a simple structure and an enhanced reaction strength, without dead angles, deposition nor congestion of the solid phase.

The object of this invention is achieved as follows: based on the teachings of the Chinese patent for utility model No. ZL02238264.X, according to which the cone body and conical ring which constitute the conical build-in member and were formed by rotating straight line or poly-line round a rotation axis, are changed into a rotator and an annular rotator which are formed by rotating a curved line round a rotation axis as required, the curved line may also include a part of straight line and/or curved line, so as to satisfy different requirements of various reactions. Meanwhile, in order to enhance the maneuverability of the multiphase reactor during its operation, some improvements have been made, which are concerned about the molding of and connection between the shell, the rotator, and the annular rotator, as well as about the shape of the shell. The characteristics of the present multiphase reactor are as follows: a rotary build-in member, comprised of a rotator and an annular rotator, is installed inside the shell of the multiphase reactor. The shell of the reactor is cylindrical. The surface of the shell can be smooth, or can be waved transversely or longitudinally. The waved shape can be formed by a curved line or a poly-line. The shell of the reactor is cylindrical, and the inner surface of the shell is smooth, or waved transversely or longitudinally, wherein the shell with waved inner surface is formed by rotating a curved line or a poly-line round a rotation axis.

The rotator in the above mentioned rotary build-in member is formed by

rotating the curved line, whose two ends are connected with the two ends of the rotation axis respectively and which is in the same plane with the rotation axis, round the rotation axis. It may be hollow with the required wall thickness, or may be solid. The annular rotator is formed by rotating a straight line and a curved line round the rotation axis, wherein the straight line is parallel to the rotation axis, and the two ends of the curved line are connected with the two ends of the straight line respectively, and the straight line, the curved line and the rotation axis are within one plane. The distance between the straight line and the rotation axis is longer than that between the curved line and the rotation axis, and is exactly equal to the radius of the inner wall of the shell. The annular rotator may be hollow. Even the cylindrical surface that is formed by rotating the straight line round the axis can be omitted, as long as the rotation surface formed by rotating the said curved line has the required wall thickness. It may also be a solid rotator.

The curved line, based on which the rotator and the annular rotator are formed, can be composed of curved line segments with different profiles, but these curved line segments are in the same plane with the rotation axis. The curved line is preferred to be simple and to form the rotation surfaces in ease. The top and the bottom ends of the annular rotator are connected to the shell so that the whole annular rotator is supported on the shell of the reactor, or can be integrated with the shell by molding. The rotator is supported on the shell of the reactor by a supporting frame, or can be integrated with the shell by molding. The annular rotator and the rotator are installed coaxially in the reactor. The maximum diameter of the rotator should not be less than the inner diameter of the annular rotator. Normally, the rotator is installed over the annular rotator with an appropriate distance between them, so as to make sure that there is enough space for feedstocks to pass through.

A rotator, an annular rotator and their corresponding shell constitute a reaction unit. A multiphase reactor can comprise one reaction unit or several reaction units. In the process of manufacturing, assembly, and installation of the reaction units, the shell, the rotator, and the annular rotator can be produced separately, then the rotator and the annular rotator are installed in order to the shell by welding, riveting, screwing, or bolting, in compliance with the requirements. Alternatively, the finished rotator and annular rotator can be installed to a corresponding section of the shell, then the sections of the shell are installed together by welding, riveting, screwing, flanged connection, or bell and spigot joint. In a third way, the rotator, the annular rotator and the corresponding section of the shell are made as an unit in a way of one-shot molding, then the sections of the shell are installed together by welding, riveting, screwing, flanged connection, or bell and spigot joint. In a fourth way, the rotator and a corresponding section of the shell are installed together in a way of one-shot molding, and the annular rotator and its corresponding section

of the shell are installed together in a way of one-shot molding, then the two parts above-mentioned are connected together into a unit by welding, riveting, screwing, flanged connection, or bell and spigot joint; finally, all of units are connected together.

This invention possesses the following merits:

1. The previous structure of cone- shaped build-in member is replaced by the structure of a rotary build-in member, and the previous conical surface is replaced by a rotary surface. During the design of the reactor, the flow pattern of the fluid can be controlled by selecting the form of the rotary surface, so as to improve reaction process.

2. The previous structure of the conical build-in member is kept, so that several fluid curtains with different diameters are formed in the reactor. The previous build-in member is kept, so that the velocities and directions of the fluid are forced to change continuously. These measures improve the contact of gas-liquid-solid three-phase and enhance the reactions among different phases.

3. The structure of the rotary build-in member is basically the same as the structure of the conical build-in member except the rotary surface of the build-in member. Nevertheless this difference does not make the structure of the reactor complicated, and the characteristics such as simple in structure, easy manufacturing and low cost are remained.

4. A variety of methods concerning the connection and combination of the units or components are provided to the user's option when implementing this invention.

Brief Description of The Drawings

1. FIG.1 shows a partial cross-section and its three-dimensional view of one embodiment of the multiphase reactor of the invention.

2. FIG.2 shows the partial cross-section and its three-dimensional view of another embodiment of the multiphase reactor of the invention.

3. FIG.3 shows the partial cross-section and its three-dimensional view of the multiphase reactor known from the prior art.

The differences between the multiphase reactor of the present invention and the prior art multiphase reactor are shown clearly in the Fig 1, Fig 2 and Fig 3. The rotator and annular rotator of the multiphase reactor of the present

invention are formed by rotating curved lines, which are in the same plane with the rotation axis. However, the cone body and the conical ring in the cone-shaped build-in member are formed by rotating a straight line or poly-line, which is in the same plane with the axis.

Embodiments

The following is the detailed description of embodiments referring to the Figures.

EXAMPLE 1

As shown in FIG. 1, the multiphase reactor includes a shell and a rotary build-in member. The shell 1 of the reactor can be made as a cylinder with smooth surface. The rotary build-in member, consisted of the rotator 2 and the annular rotator 3, is installed inside the shell 1. The rotator 2 is formed by rotating the curved line which is formed by connecting several arcs with different radii. It is obviously different from the cone in Fig 3. The annular rotator is also formed by rotating the curved line, which is formed by connecting several arcs with different radii, and is different from the conical ring in Fig 3. The annular rotator 3 can be welded or riveted on the shell 1 of the reactor, and the rotator 2 is supported on the shell 1 by a fixed bolster. The rotator is mounted on the annular rotator with enough space left in between, whereby the fluids can flow through smoothly. The diameter of the rotator 2 φ DA is not less than the inner diameterφDB of the annular rotator , so as to strengthen the change of the fluid velocity and to speed up the mass transfer. This type of structure is suitable for the counter-current contact of the downward feedstock slurry and the upward gaseous fluid, and also suitable for the co-current contact of the feedstock slurry and the gaseous fluid simultaneously downward.

EXAMPLE 2

As shown in FIG.2, the multiphase reactor includes a shell and a rotary build-in member. The shell 1 of the reactor can be manufactured into a cylinder shape, the rotary build-in member, composed of the rotator 2 and the annular rotator 3, is installed inside the shell 1. The rotator 2, formed by rotating another curved line, has the shape that is different from the cone body shown in Fig 3 and the rotator shown in Fig 1.The annular rotator 3, formed by rotating another curved line, has the shape that is different from the conical ring shown in Fig 3 and the annular rotator shown in Fig 1. The rotator is mounted on the

annular rotator with enough space left in between, whereby the fluids can flow through smoothly. The diameter φDAof the rotator 2 is not less than the inner diameterφDB of the annular rotator, so as to strengthen the change of the fluid velocity and to speed up the mass transfer. This type of structure is suitable for the counter-current contact of the downward feedstock slurry and the upward gaseous fluid, and also suitable for the co-current contact of the feedstock slurry and the gaseous fluid simultaneously downward.

As an embodiment of the present invention, Ningbo East Copper Company Smeltery modified its previously used cone-shaped build-in member as shown in FIG.3 by using the rotary build-in member as shown in Fig 2. Under the substantially same operation conditions, the recycling slurry was decreased by 6%, indicating that the change of the shape of the build-in member conduces to intensifying the contact of the gas-liquid-solid three phases, and to speeding up the mass transfer.

The above embodiments describe one technical solution of the present invention. Some technical modifications based on the present invention without departure from the spirits of inventive concept, such as those being added with some radial troughs on the surface of the rotator and annular rotator, etc., are all within the protection scope of the invention.

Claims

What is claimed:

1.A multiphase reactor, comprising a reactor shell, wherein a rotary build-in member comprising a rotator and an annular rotator is installed inside the reactor shell.

2. A multiphase reactor according to claim 1, wherein the said reactor shell is in a cylinder shape with a smooth inner surface, or an inner surface waved transversely or longitudinally, and the waved inner surface can be formed by rotating a curved line or a poly-line.

3. A multiphase reactor according to claim 1, wherein the structure of the said rotary build-in member are as follows: the annular rotator 3 is settled on the reactor shell 1 and formed by rotating a straight line and a curved line round the rotation axis, wherein the straight line is parallel to the rotation axis, and the two ends of the curved line are connected with the two ends of the straight line respectively, and the straight line and the curved line are within same plane; the distance between the straight line and the rotation axis is longer than that between the curved line and the rotation axis; correspondingly, the rotator 2 is mounted on the annular rotator, and is formed by rotating the curved line round the rotation axis, the curved line's two ends are connected with the two ends of the rotation axis respectively and the curved line and the rotation axis are within same plane; the rotator and the annular rotator are coaxial.

4. A multiphase reactor according to claim 1, wherein the maximum diameter ΦDA of the said rotator 2 is not less than the inner diameter of the annular rotatorφDB.

5. A multiphase reactor according to claim 1, wherein the rotary build-in member comprising the rotator 2 and the annular rotator 3 as well as their corresponding shell are integrated together to form a unit; several such units can be mounted in the reactor from the top to the bottom.

6. A multiphase reactor according to claims 1, 2, 3 or 5, wherein the reactor shell, the rotator and the annular rotator are manufactured separately, then installed as desired by welding, riveting, screwing or bolting; or installed them as a reaction unit in a way of one-shot molding; or the rotator and a corresponding section of the shell are installed together in a way of one-shot molding, and the annular rotator and its corresponding section of the shell are installed together in a way of one-shot molding, then the two parts above-mentioned are connected together into an unit by welding, riveting, screwing, flanged connection, or by bell and spigot joint.

7. A multiphase reactor according to claim 5, wherein the units can be connected together in order by welding, riveting, bolting, flanged connection, or by bell and spigot joint.

Abstract

This invention relates to a multiphase reactor which is especially suitable for desulfurization of flue gas. A rotary build-in member comprising a rotator and an annular rotator, is fixed on the shell of the reactor. The shell is cylindrical, and its surface is smooth or waved. The maximum diameter of the rotator is no less than the inner diameter of the annular rotator. The rotator is installed on the annular rotator coaxially. One rotary build-in member and its corresponding shell constitute an unit, and the reactor may have one or more such units. The multiphase reactor can effectively improve the flow pattern of the fluid and the contact of gas-liquid-solid three-phase of the reactants, speed up the mass transfer, and prevent deposition of the solid phase. The reactor is simple in structure and convenient for use. It can be used in the fields such as environmental protection, chemical engineering, metallurgy, and architectural industries.